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Report A-012/2018

Accident involving a Cessna
525C – CJ4, registration
EC-MOQ, operated by Aluminios
Cortizo, at the Santiago
de Compostela Airport
(A Coruña) on 4 May 2018



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Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) n° 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

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Abbreviations

° ' "	Sexagesimal degrees, minutes and seconds
°C	Degrees centigrade
A/C	Aircraft
AENA	Spanish airports and air navigation
AESA	National Aviation Safety Agency
AMM	Aircraft maintenance manual
AMS	ASTM material standards
ASL	Alert service letter
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
BEA	French investigation agency
CPL(A)	Commercial pilot license (airplane)
CVR	Cockpit voice recorder
DEG	Degrees
DFDR	Digital flight data recorder
EICAS	Engine-indicating and crew-alerting system
FH	Flight hours
ft	Feet
ft/min	Feet per minute
g	Acceleration due to gravity
h	Hours
hPa	Hectopascals
IAS	Indicated airspeed
ILS	Instrument landing system
In	Inches
IFR	Instrument flight rules
IR(A)	Instrument rating (airplane)
Kg	Kilograms
kHz	Kilohertz
Km	Kilometers
ksi	Kilopounds per square inch
Kt	Knots
lb	Pounds
LVP	Low-visibility procedure
m	Meters
MAG	Magnetic
METAR	Meteorological aerodrome report
MEP	Multi-engine piston rating
MHz	Megahertz
Min	Minutes

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MP	Multipilot
MTOW	Maximum takeoff weight)
N	North
NM	Nautical miles
PAPI	Precision approach path indicator
P/N	Part number
psi	Pounds per square inch
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
S	South
s	Seconds
SL	Service letter
S/N	Serial number
Tm	Metric ton
TWR	Control tower
UTC	Coordinated universal time
VFR	Visual flight rules
W	West
WOW	Weight on wheels

Synopsis

Owner: Aluminios Cortizo
Operator: Aluminios Cortizo
Aircraft: Cessna 525C - Citation Jet 4, registration EC-MOQ
Date and time of accident: 4 May 2018 at 18:10 UTC¹
Site of accident: Santiago de Compostela Airport (A Coruña)
Persons on board: 2 crew and 4 passengers, uninjured
Type of flight: General aviation – Business
Date of approval:

Summary of event:

On Friday, 4 May 2019, a Cessna 525-C aircraft, registration EC-MOQ, experienced a collapse of the left main gear during the landing run just as it was starting to vacate the runway via taxiway E3. The aircraft came to a stop inside the runway.

The marshaller noticed that the left gear had collapsed and was outside its extension-retraction axis. Both engines were turned off, the aircraft was secured and the passengers were evacuated.

Runway 17/35 at the Santiago airport remained closed for two hours and 15 minutes while the aircraft was raised and towed to its hangar.

The occupants were not injured. The damage to the aircraft was limited to the left main landing gear leg and to part of the left wing, which was affected by deformations and the collapse of the left landing gear leg.

A subsequent inspection showed that the bolt that attaches the aft trunnion pin to the trunnion was installed incorrectly, which allowed the trunnion pin to shift to the rear, decoupling from the trunnion and causing the leg to collapse. The bolt was also verified to be incorrectly installed in the right landing gear leg, although the trunnion pin did not come out of its fitting and the right leg remained in its position.

The collapse of the left landing gear leg was caused by an error when installing the aft bolt into the trunnion pin, which allowed the trunnion pin to move in the trunnion fitting in the aft wing spar.

¹ All times in this report are in UTC. To obtain local time, add 2 hours to UTC.

The installation mistake in the main landing gear legs and the accumulation of other minor errors indicate that the maintenance facilities of the aircraft manufacturer, Textron Aviation, do not have standard installation (removal) procedures that are known to all of the personnel involved.

As a result, the following safety recommendation is issued: It is recommended that the manufacturer of the Cessna 525C, Textron Aviation, review its procedures and their application at its maintenance centers involving the installation (removal) of the main landing gear legs and all of the maintenance tasks that deal with or affect these components; including subsequent inspections of critical elements such as bolts and pins.

1. FACTUAL INFORMATION

1.1. History of the flight

On Friday, 4 May 2018, a Cessna 525-C aircraft, registration EC-MOQ, landed at the airport of Santiago de Compostela on a private flight from Zagreb (Croatia).

The instrumental approach and landing on runway 35 were uneventful, and the aircraft made contact with the runway surface in the touchdown zone at the reference speed and in a correct landing attitude, according to the crew's statement. During the landing run, steering control was normal and the control center instructed the crew to vacate the runway.

After starting the left turn to exit the runway via taxiway E3, the airplane leaned to the left, which the crew interpreted as a flat tire. A few seconds later, the left leg collapsed. A message was received on the EICAS that there was no indication on the weight on wheel sensor (WOW).

The crew stopped the aircraft inside the runway and informed the tower of the emergency. The tower asked the marshaller to do an onsite visual inspection, which confirmed that the left main gear had collapsed and was outside its extension-retraction rotational axis. The crew turned off the engines, secured the aircraft and evacuated the passengers.

Runway 17/35 at the airport of Santiago de Compostela remained closed for two hours and fifteen minutes while the aircraft was hoisted and towed to its hangar.



Figure 1 – Position and condition of the aircraft after collapse of left leg

The aircraft's occupants, crew and passengers, were uninjured.

The damage to the aircraft was limited to the left landing gear assembly and part of the left wing, which had been affected by the collapse of the same-side landing gear leg. These deformations and damage to the left wing affected primary structural components.

A check of the landing gear and subsequent inspection showed that the bolt was incorrectly installed in the aft trunnion pin on the left leg, which allowed the trunnion pin to move backward and decouple from the trunnion. This caused the leg to collapse as it turned forward and to the right, pivoting on the hydraulic actuator.

This bolt was also verified to be incorrectly installed in the aft trunnion pin on the right landing gear leg, although the trunnion pin did not come out of its coupling and the right trunnion remained in its position, with no apparent failure.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				N/A
None	2	4	6	N/A
TOTAL				

1.3. Damage to aircraft

The damage to the left wing, caused by the movement of the left gear leg outside its housing while supporting weight, affected the wing spars. As these are primary structural components, the damage rendered the wing unused.

Most of the components and accessories on the landing gear assembly were damaged and had to be replaced. There was even a rupture of a connection in the brake lines, which caused brake fluid to be spilled.

1.4. Other damage

There was no other damage.

1.5. Personnel information

1.5.1. Captain

The pilot in command, a 48-year-old Spanish national, had a commercial pilot license first issued by Spain's National Aviation Safety Agency (AESA) on 10 December 2007, and an airline transport pilot license issued on 21 March 2017, valid indefinitely.

He also had class-1 and -2 medical certificates that were valid until 18 July 2018.

The pilot had instrument (IR(A)) and C-525 type ratings, both of which were valid until 31 March 2019.

According to the information provided, he had a total of 6307:55 flight hours, of which 33:40 had been on the same aircraft type as the accident aircraft.

He had flown 68:50 h in the last three months, 32:45 h in the last month and 10:40 h in the last week.

1.5.2. Copilot

The copilot, a 35 year old Spanish national, had a commercial pilot license (CPL(A)) first issued by Spain's National Aviation Safety Agency (AESA) on 17 March 2005 that was valid indefinitely.

He had a class-1 medical certificate that was valid until 24 January 2019, and a class-2 certificate that was valid until 24 January 2021.

He had instrument (IR(A)) and C-525/MP type ratings, both of which were valid until 30 April 2019.

According to the information provided, he had a total of 1401 flight hours, of which 891 had been on the same aircraft type as the accident aircraft.

He had flown 93:02 h in the last three months, 37:01 h in the last month and 10:40 h in the last week.

1.6. Aircraft information

1.6.1. General information

- Manufacturer: Cessna - Textron Aviation
- Model: 525C – Citation Jet 4
- Serial number: 525C - 0161
- Year of manufacture: 2014
- Airworthiness review certificate valid until 15 November 2018
- Engines, number/manufacturer and model: two Williams FJ 44 - 4A
- Empty weight: 4,577 kg
- Maximum takeoff weight: 7,760 kg
- Total airframe and engine hours: 861:30
- Total aircraft cycles: 738

1.6.2. Operational and maintenance history

After being placed in service following its manufacture, in August 2014, the aircraft did its test flights with temporary registration N-52081; then, in September, it began operations at Atlas Air Service, with registration D-CJUG, which also performed its maintenance until mid-2016.

In May 2016, a trade-in inspection and work scope on a pre-owned A/C was carried out at Cessna Düsseldorf, with 278 flight hours and 293 cycles on the aircraft.

In July 2016, it was assigned a new registration, D-CDUS, under ownership to Cessna, and it was operated by E Aviation. It was maintained by Cessna Dusseldorf Citation Service Center GmbH.

The aircraft was transferred to the current operator, Aluminios Cortizo, with delivery in February 2017, and assigned its current registration, EC-MOQ. From then on, the aircraft was maintained by the Cessna Citation Service Center in Valencia.

At that point, the aircraft had 448 hours and 445 cycles of total flight activity. At the time of the accident, the aircraft had a total of 861:30 flight hours and 738 cycles.

1.6.3. Landing gear maintenance record

The landing gear on this aircraft model was affected by Alert Service Letter (ASL) 525C-32-01, issued on 19 July 2012, on the potentially incorrect installation, during assembly at the factory, of the bolt in the aft trunnion pin on both main gear legs.

ASL 525C-32-01 contains instructions for inspecting the installation of the aft trunnion pin in the main gear, although the S/N of the aircraft, 0161, was not affected, as corrective steps had already been taken at the factory. The ASL had to be implemented before the next flight.

From May to July 2016, as part of the special inspection due to change of ownership, both main landing gear legs were checked for corrosion damage. Both trunnions were disassembled on 7 June and reinstalled on 10 June 2016. The work orders were signed by two different technicians. This inspection, which includes greasing the landing gear, does not necessarily require removing/reinstalling the gear.

The corrosion inspection of the landing gear, required every twelve months, was carried out in December 2016. This inspection does not require removing the landing gear, and the gear was indeed left in place.

In November 2017, at the Cessna service center in Valencia, the bonding jumper on the left main landing gear leg was replaced due to damage found during the inspection, which required disassembling and reinstalling with sealant the bolt (P/N AN3-42) in the aft trunnion pin. This task does not require removing or adjusting the aft or forward trunnion pins. The maintenance records from this inspection confirmed that the trunnion pins on the left gear were not removed, since the aircraft was not hoisted on jacks.

The last visual inspection of the landing gear for corrosion was done at the same maintenance center, the Cessna Citation Service Center in Valencia, in March 2018. The landing gear was not removed.

1.7. Meteorological information

The following information was contained in the 18:00 UTC METAR for the airport of Santiago de Compostela: average wind direction from the northeast, 040°, at an average speed of 12 kt, varying in direction between 340° and 80°, unlimited ceiling and visibility, temperature of 17° C and dew point of 2° C, QNH of 1017 hPa and no significant atmospheric phenomena.

The information for the next half hour, provided in the 18:30 METAR, was mostly similar, meaning stable weather conditions that were favorable to flight operations and no significant phenomena.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The radio communications between the aircraft and the various control centers were normal during the flight, including the clearance from the Santiago control tower to land on runway 35. This instruction included the final weather information provided, wind from 020° at 8 kt, gusting to 20 kt.

During the landing run, the controller informed the crew that they could turn left to go to their assigned parking stand, number 18. The crew began the turn to exit via taxiway E3, the nearest taxiway, when they felt the left wing drop slightly.

The emergency report made on the radio and the coordination with airport services were smooth, with no delays or complications.

1.10. Aerodrome information

The Santiago de Compostela airport is located 10 km northeast of the city. Its reference point is at an elevation of 370 m (1213 ft). Its ICAO identifier is LEST and it is open 24 hours a day. The airport has low-visibility procedures (LVP) in place due to the relative frequency of weather conditions that reduce visibility in the region.

It has one asphalt runway in a 17/35 orientation and a landing distance available of 3,020 meters. Runway 35, in use when the aircraft landed, has simple approach lighting over 420 meters (consisting of a row of lights along the extended runway centerline forming a crossbar 18 or 30 meters long 300 meters away from the threshold), threshold identification lights and a 3° PAPI. The 35 threshold also has an ILS CAT I for IFR approaches. As specified in the AIP, and also included in the AP Operations Manual,

handling companies provide tractors and pushback bars, which were available on the day of the event. There was a commitment from companies in the area with the capacity to move loads weighing up to 500 Tm to provide this service within three hours.

1.11. Flight recorders

The aircraft had two flight recorders, a cockpit voice recorder (CVR) and a digital flight data recorder (DFDR).

1.11.1. CVR–Cockpit voice recorder

The CVR, an L-3 Aviation Recorders FA-2100, P/N 2100-1025-22 and S/N 000949436, was removed from the aircraft. Its contents were then downloaded and the conversations transcribed.

This recording confirms the routine nature of the procedures and the approach to and landing on runway 35, until the left landing gear leg unlocked, turned and collapsed, as described in point 1.1 through the crew's statement. The first reference to the appearance of a problem (an expression of surprise due to something out of the ordinary) is heard 17 seconds before the instruction is received from the control tower, during the landing run, to turn left and vacate the runway toward stand 18.

1.11.2. DFDR–Digital flight data recorder

The DFDR, an L3 Aviation Recorders FA-2100, P/N 2100-2045-00, was removed from the aircraft in order to recover the data recorded on it.

The analysis focused on the final approach and landing phases. The study relied on the analog parameters for the calculated airspeed (CAS, in kt), pressure altitude (in ft) and magnetic heading (in degrees), and on the discrete ground/air parameters for the three landing gear legs (Left Gear, Right Gear and Nose Gear WOW), as well as on the Master Caution indicator. In addition to these baseline parameters, also used were the parameters for vertical acceleration (in g's), longitudinal acceleration (in g's), lateral acceleration (in g's) and brake system pressure (Brake Pressure Left and Brake Pressure Right in psi).

During the final approach, once the aircraft was lined up with the localizer, the approach was stabilized. The aircraft touched down at 18:05:15, with a smooth vertical acceleration ranging from 0.8 to 1.4 g. The lateral acceleration was also small, with a maximum value of 0.15 g, until the aircraft stopped.

Sixteen seconds after touching down on the runway (18:05:31), with the airplane still traveling at 45 kt, the WOW ground/air parameter for the left leg indicated "air", a reading that remained unchanged until the end of the recording, even though the wheel was in fact on the ground. At the same time, there was a slight increase in the vertical and lateral accelerations, and the Master Caution was activated. These readings indicate and are coincident with the movement of the retraction axis of the left leg outside its housing.

Twenty-two seconds later, as the airplane had started to turn left to vacate the runway, the left main gear leg collapsed, causing the left wing to dip. The aircraft then stopped on runway 35.

Since the WOW indicator for the nose wheel (four readings per second) indicated contact at the same time as the main wheels, this shows that the aircraft's attitude upon landing was very flat. This led investigators to examine the aircraft's four previous landings.

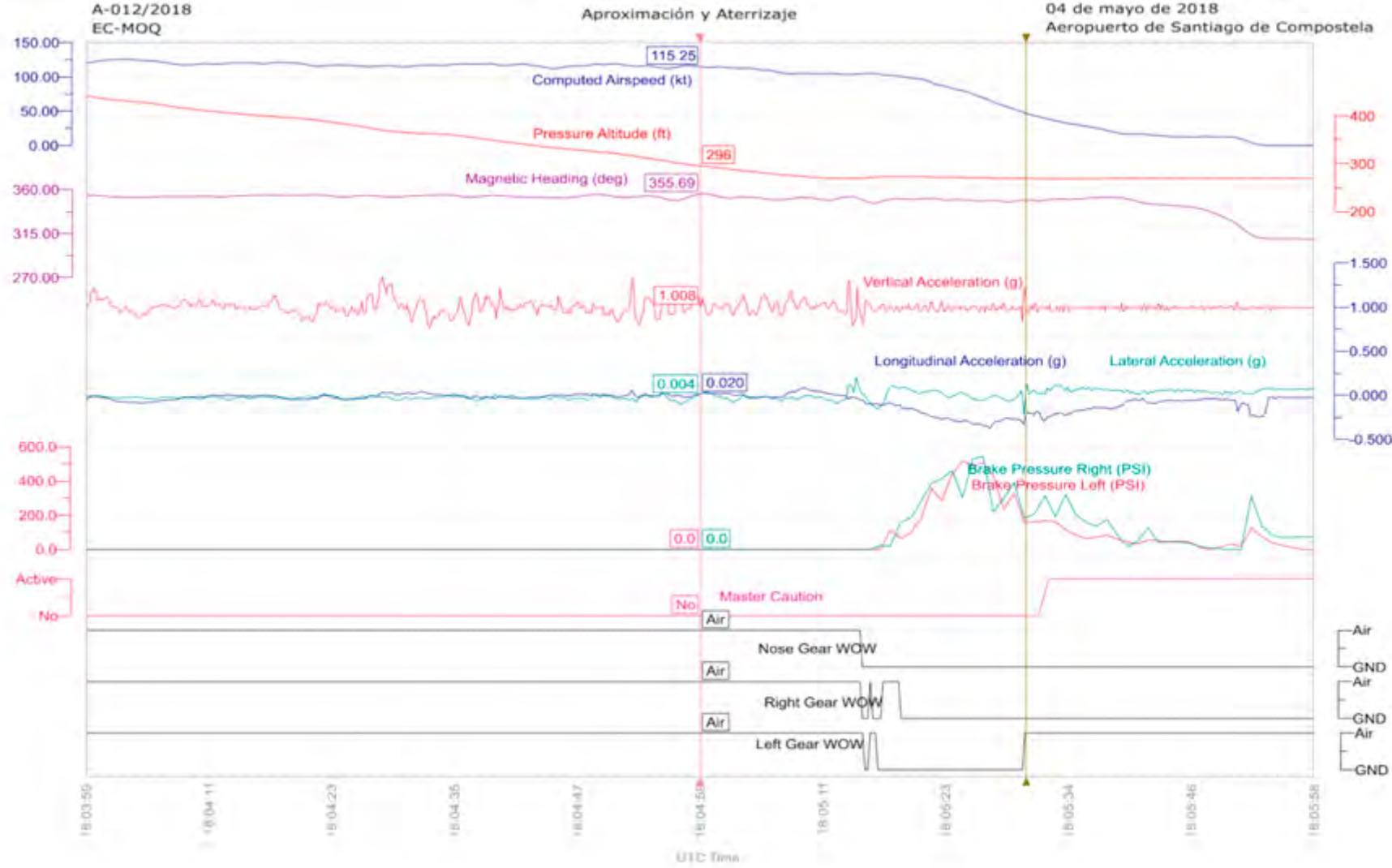
In the four landings before the accident landing, contact was made first with the main gear wheels and then by the nose wheel, except for one, when all three wheels touched down at the same time. In one landing, one of the main gear wheels bounced and after stabilizing on the ground, the nose wheel bounced several times before making final contact.

The landing sequence in the accident flight was slightly different, with the nose wheel making contact first, then the right main gear wheel and finally the left main gear wheel. The nose wheel did not bounce, while the two main gear wheels bounced, the right wheel twice and the left wheel once, before staying in contact with the runway.

The pitch angle (in degrees) from the four landings before the accident landing was analyzed and found to be at least -2° (nose-down attitude). The lowest angle was for the three-wheel landing, with a reading of -1.93° . On the accident landing, the angle was 2.64° on initial contact. This value remained below -2.20° for four additional seconds, while the main gear wheels bounced.

Despite this apparently abnormal attitude of the aircraft upon contacting the runway, with very low or even negative flare angles, this is not thought to have placed excessive loads on the main gear legs (the nose leg is not affected) during the landing, since the landings were smooth, as evidenced by the vertical acceleration peaks, which did not reach ± 0.5 g on any landing.

The graph below shows the trends in the DFDR parameters over two minutes during the landing, which clearly indicate the instant when the left leg collapsed.



1.12. Wreckage and impact information

At the start of the left turn to exit runway 35 via taxiway E3, both pilots felt the left wing smoothly and gradually fall before noticing that the left leg appeared to have collapsed. They then stopped the aircraft.

They confirmed with the marshaller that they could not taxi under their own power, stopped the engines, secured the aircraft and evacuated the passengers. The aircraft remained in runway 17/35, rendering it inoperative.

Preparations were made to raise the aircraft and rest the left wing on an element that allowed it to move so that the airplane could be removed to a safe location where it could then be examined. The aircraft owner finally procured the resources necessary from the airport – tractor and towbar from the operator’s handling company, components to assist with the lifting provided by a company with an arrangement with the airport, and a crane obtained directly by the operator – after which the aircraft was moved to its hangar.

While raising the aircraft to remove it from the runway, additional damage was done to the skin on the left wing, mainly along the trailing edge and the wing root.

The left leg trunnion fitting was found outside its forward and aft supports at both wing spars (star-shaped reinforcement with a support coupling where both trunnion fittings rest). After coming out of the longitudinal axis of the gear (about which it extends and retracts), it turned forward and to the right. This leg remained attached by



Figure 2 – Left leg outside the wheel well (l), and right leg in its normal extended position (r)

the hydraulic extension/retraction actuator, and its weight was supported by the lower wing structure.

1.13. Medical and pathological information

There are no indications that any of the crew members involved in operating the aircraft may have been affected by a significant medical or pathological condition.

1.14. Fire

There was no fire.

1.15. Survival aspects

The safety of the aircraft's occupants was not compromised at any point.

1.16. Tests and research

1.16.1. Initial inspection and disassembly

The initial examination of the left leg showed that the left trunnion was outside its housing on both sides of the trunnion fitting axes in the coupling in the left-wing spars. The aft trunnion pin was in its housing in the trunnion fitting and the bolt was intact in the trunnion, confirming it had been incorrectly installed outside the trunnion pin, and thus was not holding it in place.



Figure 3 – Left aft trunnion pin

This condition is consistent with an incorrect installation already described by the manufacturer, which led it to issue Alert Service Letter (ASL) 525C-32-01, "Landing gear – Aft main landing gear trunnion pin inspection", on 19 July 2012.

As in these initial investigations into the component that failed, the type of failure was readily identifiable and was included in the preliminary report on the event. The investigation focused on this component, its history and previous events involving this system.

Provided in this report are illustrations supplied by Cessna in its ASL 525C-32-01, Figure 1 Aft Main Landing Gear Trunnion Inspection (sheet 1)", with two close-ups showing the position of the bolt, one correctly installed and another incorrectly installed, as well as two views from behind showing both conditions.

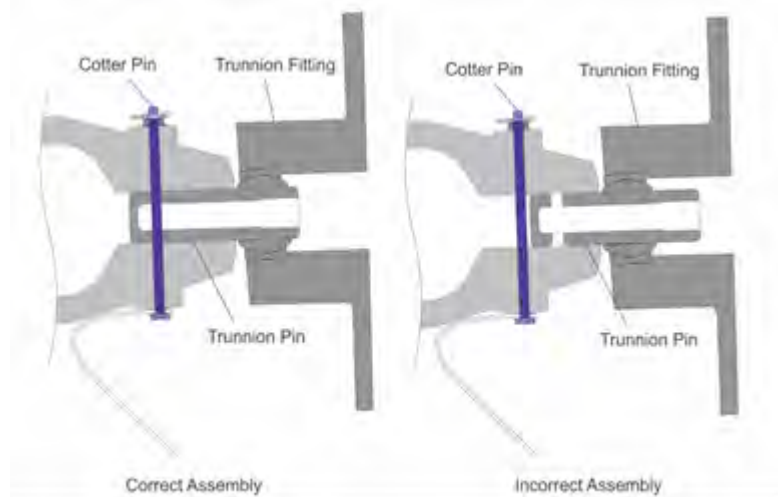


Diagram 2 – Detail of the bolt installed correctly and incorrectly

1.16.2. Examination of assembly of aft and forward trunnion pins in both landing gear legs.

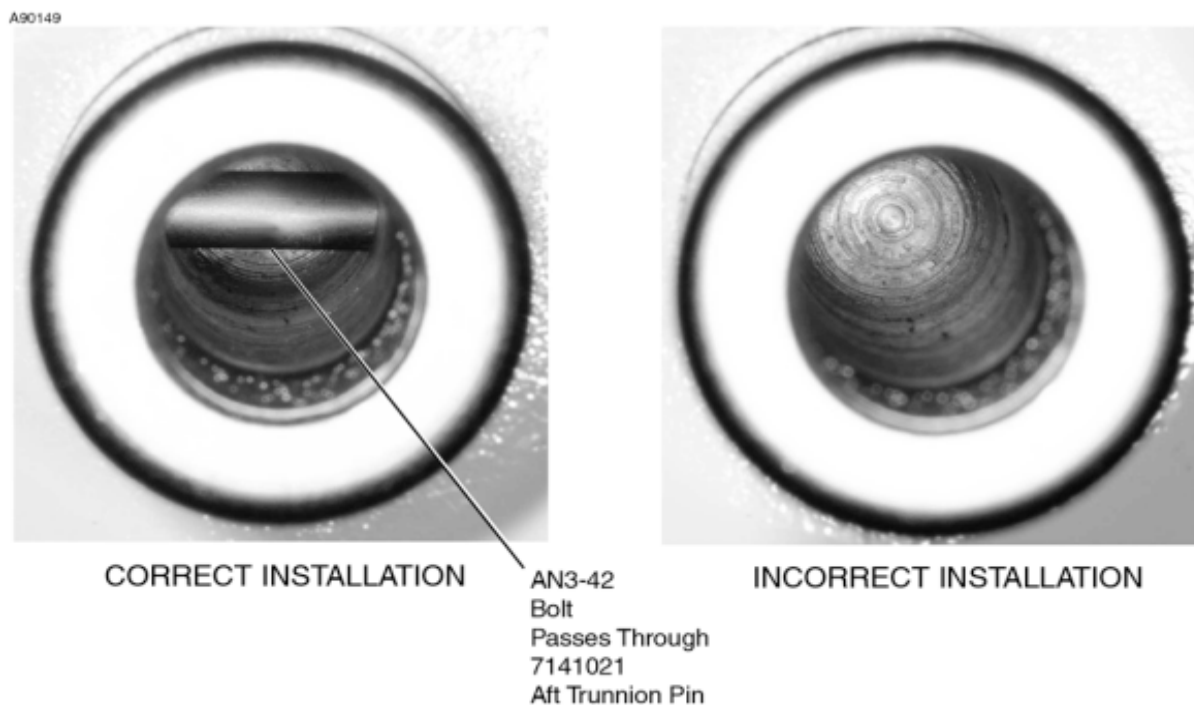


Figure 4 – View inside the aft trunnion pin

The components used to install both main landing gear legs on the aircraft (four trunnion pins for the main landing gear and their four associated bolts) were removed and sent to the manufacturer, Cessna – Textron Aviation, for inspection.

This inspection yielded the following findings:

1. The forward trunnion pin on the right side, P/N 7141021-1, and its corresponding bolt only showed damage associated with normal operation or use. The trunnion pin material was 4130M, a low-alloy steel compliant with AMS 6417 and with the design strength specifications, between 270 and 295 ksi (kilopounds per square inch).
2. The forward trunnion pin on the left side, P/N 7141021-5, was incorrectly installed instead of P/N 7141021-1. It was not damaged and its measurements, composition and strength were correct, as required by the design. It was made of 4340 low-alloy steel, compliant with AMS 6414, with a strength requirement of between 200 and 220 ksi. The corresponding fixing bolt, P/N AN-3-37, was cut at the end of the trunnion pin and the central part remained inside the trunnion pin. The strength of the bolt was adequate and had broken due to shear overload.
3. The aft trunnion pin on the right side, P/N 7141021-5, was not damaged, but the contact marks on the outer diameter made by the coupling and the cadmium residue on the flat side of one end, deposited by bolt AN-3-42, suggest that the

bolt was not inserted through the trunnion pin. The trunnion pin was made of a low-alloy steel of satisfactory strength, as per the design specifications.

4. The aft trunnion pin on the left side, P/N 7141021-5, was not damaged, but the contact marks on the outer diameter made by the coupling and the cadmium residue on the flat side of one end, deposited by bolt AN-3-42, suggest that the bolt was not inserted through the trunnion pin. The trunnion pin was made of a low-alloy steel of satisfactory strength, as per the design specifications. The associated bolt, AN-3-42, exhibited an overload failure in the perforation of the threaded area for the braking wire. This bolt was made of a low-alloy steel of satisfactory strength, as per the design specifications.
5. Fluorescent liquid penetrant tests in the area of the shaft of both rear trunnion pins revealed wear in two support/assembly positions, suggesting these pins had been correctly installed at some point prior to their last installation.
6. These findings agree with the preliminary investigation report, in that both rear trunnion pins, P/N 7141021-5, were incorrectly installed before 4 May 2018, the date of the accident.

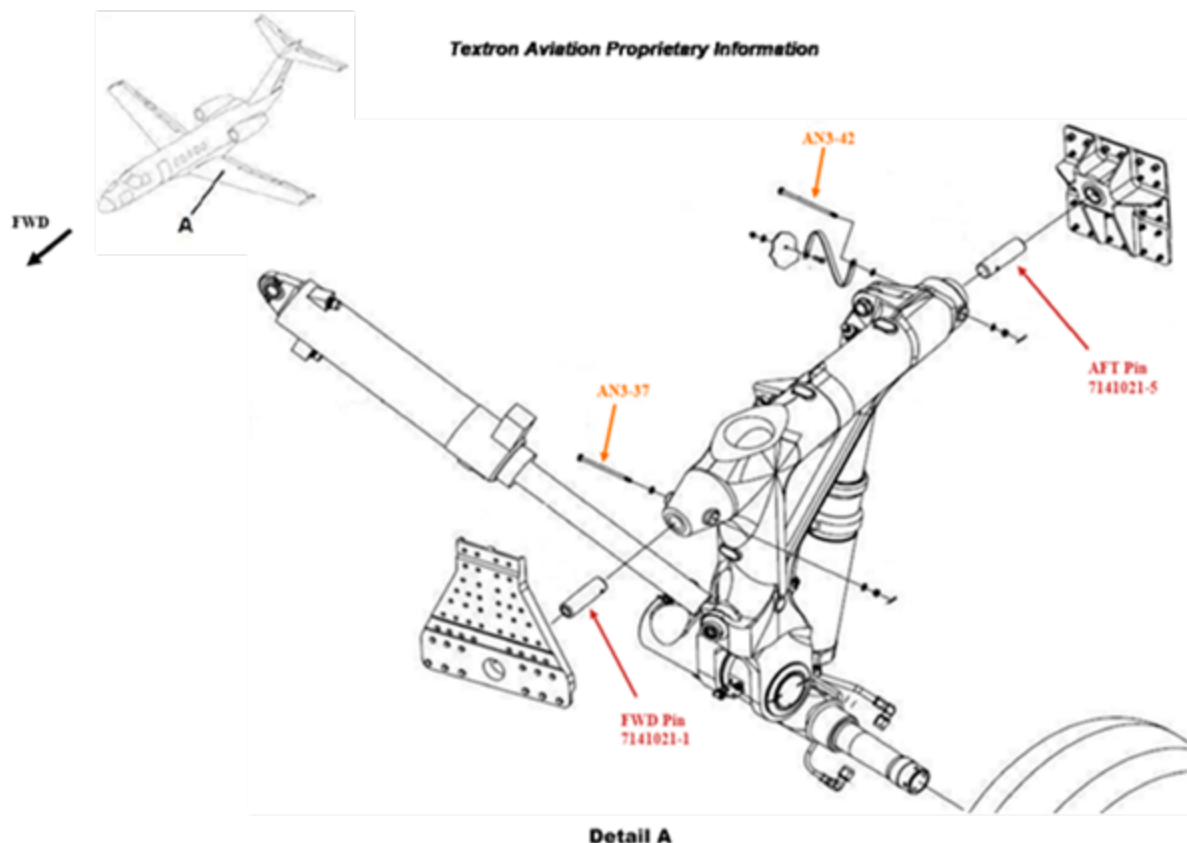


Diagram 3 – Main gear assembly

Some of the findings or characteristics deemed to be of most interest are provided below:

- The bolt, AN-3-42, of the rear support on the left side (side and trunnion pin that caused the accident), was broken at the threaded end and the other end had broken off. It contained a gray sealant residue over another black sealant. This was the only bolt of the four with residue from two different sealants, which indicates a repair of the connection with a bonding jumper on this pin. According to the maintenance history, it was replaced in November 2017.
- As to whether the aft trunnion pins were originally installed correctly or incorrectly, the presence of two adjacent surfaces with contact/wear marks with the fitting, analyzed using penetrant liquid tests, indicates that these trunnion pins had been installed correctly at some point prior to their last installation.
- The forward trunnion pin on the left side, P/N 7141021-5, used incorrectly instead of the correct pin, P/N 7141021-1, has a lower strength specification, between 200 and 220 ksi, versus that for the front pins, whose strength is specified at 270 to 295 ksi. The strength test of the trunnion pins and bolts, as well as a chemical composition analysis, revealed that these components were compliant with their design specifications.

1.17. Organizational and management information

The aircraft manufacturer appointed a support adviser to the Accredited Representative of the United States, who was actively involved from the start of the investigation and who made positive contributions to determine the history and findings involved in the event.

Despite this, and for reasons unknown to the investigators, the manufacturer recalled the adviser without replacing him, which stalled and disorganized the investigation, causing further delays in adopting potential corrective measures.

This disorganization prevented investigators from confirming or obtaining details on certain supplementary information, which was requested later:

- a) The maintenance procedure for the landing gear in effect now and on the date when the work was done on the aircraft's main landing gear, from May to July 2016, when the main gear legs were inspected and disassembled; that is, the AMM version of 525C ATA32, revision 5 (revision 6 of the AMM was in effect since March 2018).
- b) The results of the information gathered by the manufacturer after SL 525C-32-12, "Landing gear – main landing gear trunnion pin inspection", was issued, which would indicate the scope or extent of this installation error.
- c) The meaning of a marking on the head of the right-side forward trunnion pin in relation to its strength, composition or tolerance characteristics.

1.18. Additional information

The special maintenance documentation – requested by Textron as part of the work scope for the transfer of ownership of 525C-0161, carried out at the Cessna Dusseldorf facilities between May and July 2016, and which included a detailed inspection of the gear trunnions for corrosion and wear – included a material reference involving the installation of a bolt with P/N AN-3-35, which cannot correspond to any other gear component and which was not identified in the analysis of the components removed from the gear conducted by the manufacturer.

This P/N corresponds to a component that is similar to the bolts used for the front trunnion pins, AN 3-37, but shorter in length, and for the rear trunnion pins, AN 3-42, but much shorter in length.

The bolt with P/N AN-3-35 is the forward left bolt, the ends of which were severed due to overload. Its length was not measured accurately during the analysis of the gear components, and its P/N was assigned implicitly.

1.19. Useful or effective investigation techniques

Not required.

2. ANALYSIS

2.1. General

The crew were returning to the airport of Santiago de Compostela, the airplane's base of operations, on an uneventful, medium-range flight, as in previous flights. At the conclusion of the landing run, at low speed, the left main landing gear leg dislodged from its housing and collapsed. The left wing did not impact the runway surface.

Neither the weather conditions during the landing nor the statement from the occupants indicated the possibility of excessive loads during touchdown or the landing run. This was confirmed once the data recorded during the flight were extracted and analyzed.

The initial examination of the aircraft confirmed that the bolt had been incorrectly installed in the aft trunnion pin in the left leg, which shifted backward inside the trunnion fitting in the aft spar, which allowed the trunnion to decouple and the leg to collapse.

The operation of the aircraft had no influence, and thus the analysis will focus on every aspect of the aircraft, its history, design, maintenance and their possible implications.

2.2. Aircraft

In July 2012, an Alert Service Letter (ASL), 525-C-32-01, was issued pertaining to this aircraft to correct a potential defect in the initial assembly, which coincides exactly with the installation defect identified in both main landing gear legs.

An analysis of the gear components verified that both rear trunnion pins and their bolts had been in their correct positions at some point in the past. This, combined with the aircraft's maintenance history, implies that these components were correctly installed at the factory and in keeping with the referenced ASL.

The inspection of these components also revealed that work had been done on these legs on at least two occasions, though different maintenance tasks were involved:

1) One was on the occasion of a pre-owned A/C inspection due to change of ownership (trade-in work scope) at the Cessna Düsseldorf Service Center, where both main landing gear legs were checked for corrosion damage (SL 525C-32-06). This involved disassembling both main gear trunnions, although this was not required. This was completed on 14 June 2016.

2) Another was during a second corrosion inspection, in November 2017, that was done at the Cessna center in Valencia and included the replacement of the bonding jumper on the left main gear leg. This entailed removing and reinstalling the bolt (AN 3-42), with sealant, for the aft trunnion pin in order to replace the grounding braided cable, but the trunnion pin was not removed.

These components, the aft trunnion pins, therefore had been incorrectly installed for almost two years, 414 flight hours and 193 landing cycles, without any problems in the mechanism and without this situation being detected in other inspections of these landing gear assemblies, such as the corrosion inspections (required for the landing gear every twelve months).

Coincident with the investigation into the event and the analysis of the components removed from the landing gear, the aircraft manufacturer, Textron Aviation, issued service letter SL 525C-32-12 on 9 July 2018, compliance with which is mandatory, which provided instructions for inspecting the bolts on the aft trunnion of the main landing gear in case this bolt was incorrectly installed on more aircrafts. As a precaution, this document instructed that an airplane with an incorrectly installed bolt must not be moved until this condition is corrected.

Given the possibility that more aircraft could be affected by this installation defect, the manufacturer has already taken safety measures. Since the information gathered during this investigation indicates that this installation error is or seems to be isolated, and even though no feedback information is available from Textron-Cessna on the results of implementing SL 525C-32-12, no safety recommendation is issued in this regard.

2.3. Maintenance errors identified.

The following minor errors or non-conformities were identified involving the installation of the main gear legs:

- a) Error installing the bolts in the aft trunnion pins in both the left and right trunnions.
- b) The front bolt on the left side, P/N 7141021-5, was incorrectly installed instead of P/N 7141021-1.
- c) The failure to detect the incorrect installation of the bolt in the aft trunnion pin on subsequent inspections of these gear assemblies, despite ASL 525C-32-01 being issued prior to the inspections.
- d) The different stamping found on the head of the front bolt on the right side, whose meaning is unknown.
- e) The maintenance procedures for the landing gear in effect between 2016 and 2017, AMM for 525C ATA32, revision 5, according to which the tasks were performed on the landing gear and which gave rise in the installation errors. These documents were unavailable for examination, since they are not available in the manufacturer's current maintenance documentation and the manufacturer did not reply to the request for this documentation made during the investigation.
- f) The possible installation in the main gear of a shorter bolt, AN 3-35, as reflected in the work order for the gear, the presence of which was not clarified during the manufacturer's analysis of the disassembled components.

These conditions indicate a scenario at the facilities where the aircraft was maintained in which the applicable procedures were not sufficiently known to or ingrained among the personnel that employed them, personnel who were directly related with the manufacturer (Cessna Textron) and who are in a better position to consult and check with the manufacturer's technical support staff.

As a result, a safety recommendation is issued to the manufacturer of the Cessna 525C aircraft, Textron Aviation, to have it review the procedures for assembling/disassembling the main landing gear legs, and all other maintenance tasks involving these components, and how they are applied at its maintenance centers.

3. CONCLUSIONS

3.1. Findings

- All the crewmembers had valid licenses and medical certificates.
- The aircraft's documentation was in order.
- The flight during which the accident took place was otherwise uneventful.
- The aircraft's attitude when it touched down on the runway, a small negative angle of 2.64°, was abnormal but it did not exert strong forces on the main landing gear legs.
- As the aircraft was traveling at a low speed, still inside the runway, the left landing gear leg collapsed, moving forward and to the right.
- An analysis of the aircraft showed that the bolt and its mounting pin had been improperly installed in the left leg.
- The investigation also confirmed this same incorrect installation in the right gear leg, although that bolt remained in place.
- After almost two calendar years, 414 flight hours and 193 landing cycles, the aft trunnion pin on the left leg shifted to the rear inside the trunnion fitting in the aft spar, causing the trunnion to come out of its extension/retraction axis.
- The marks found in the bolts indicate that they had been installed correctly at some previous point of the aircraft's operation and flight.
- In light of the possibility that the bolt was incorrectly installed on additional aircrafts, the aircraft manufacturer, Textron Aviation, issued service letter SL 525C-32-12 on 9 July 2018 to provide instructions for inspecting the aft trunnion pins on the main landing gear.

3.2. Causes/Contributing factors

The collapse of the left landing gear leg was caused by the improper installation of the bolt in the trunnion pin, which allowed the pin to move inside the trunnion and the trunnion fitting in the aft wing spar.

4. SAFETY RECOMMENDATIONS

The installation mistake in the main landing gear legs and the accumulation of other minor errors show that the maintenance facilities of the aircraft's manufacturer, Textron Aviation, do not have standard installation (removal) procedures that are known to all of the personnel involved. As a result, the following safety recommendation is issued:

SR 24/19: It is recommended that the manufacturer of the Cessna 525C, Textron Aviation, review its procedures for assembling/disassembling the main landing gear legs, and all other maintenance tasks involving these components, and how they are applied at its maintenance centers; including the subsequent inspections of critical elements such as bolts and pins.